SEDIMENT TREND ANALYSIS (STA®)/ACOUSTIC BOTTOM MAPPING: COLUMBIA RIVER MOUTH

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Steven Hill Ph.D., P.Eng.

GeoSea Consulting (Canada) Ltd.

Acoustic Bottom Classification (ABC) at the mouth of the Columbia River

GeoSea Consulting Ltd.
Dr. S. Hill, P.Eng

Data collection

- covers a depth range of 5m to 100m
- acoustic signal from 200 kHz sonar system
- ABC data from QTCView “blue box”
- each record is an average of 5 “pings”
- ABC sampling carried out on 14 calendar days under varying weather and sea state
- Result: 104,417 records on 848 km of track

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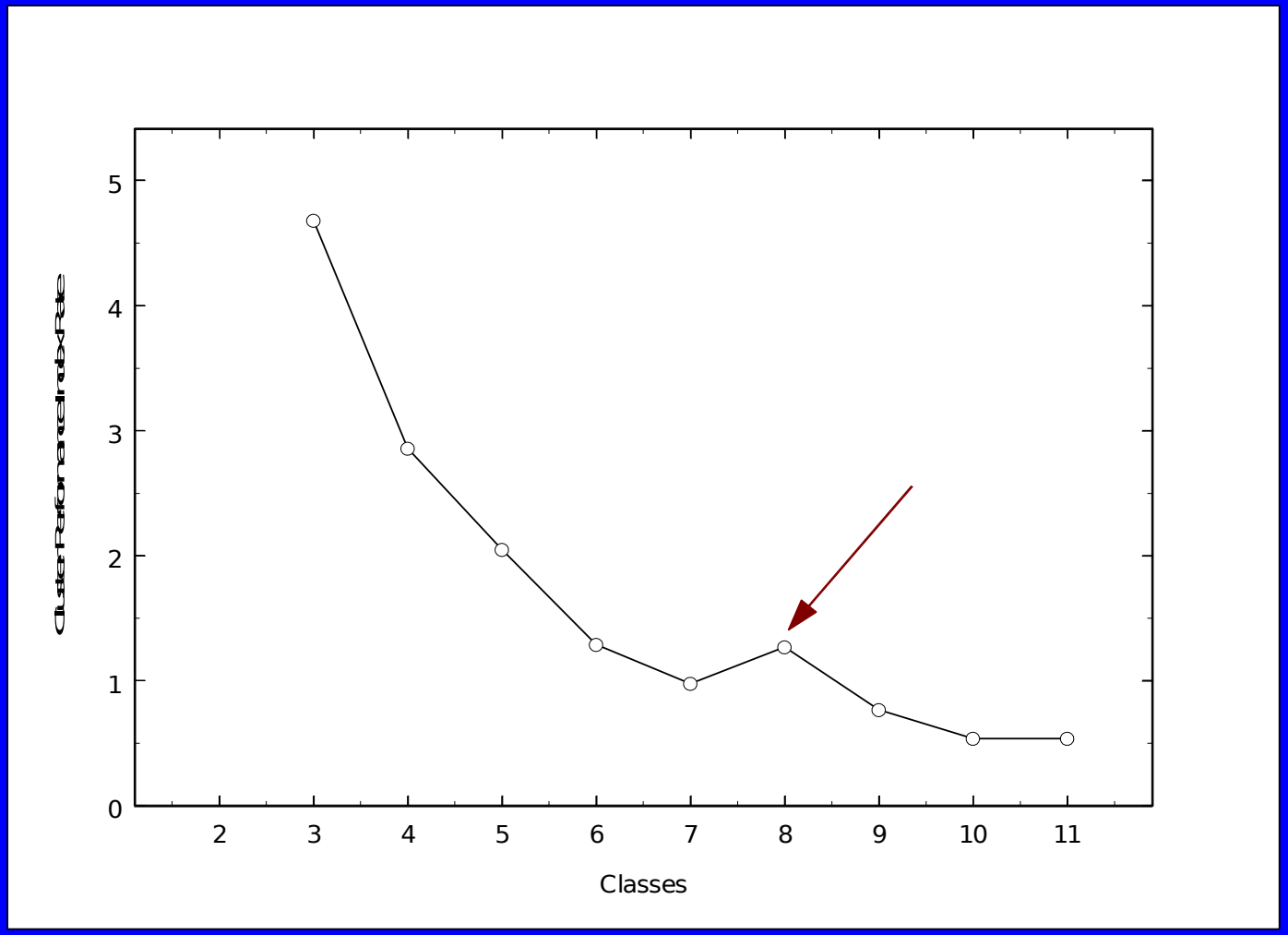
Data processing steps

- each record consists of 166 values
- Principal Components Analysis reduces these to 3 “Q-values” which account for about 70% of the total variance
- Cluster Analysis of Q-values yields the classification
- Cluster Performance Index changes indicate the appropriate number of classes

How many classes?



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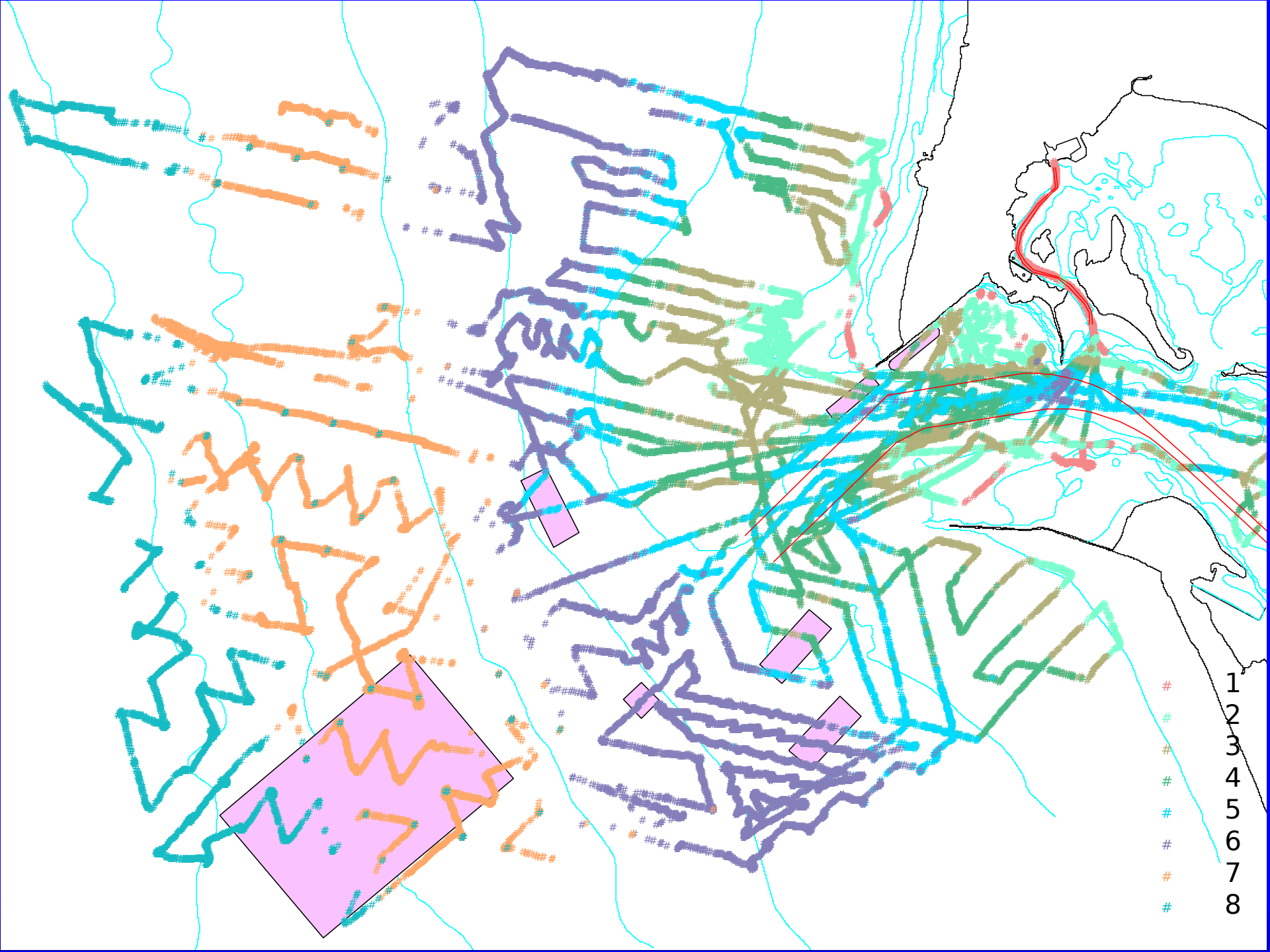
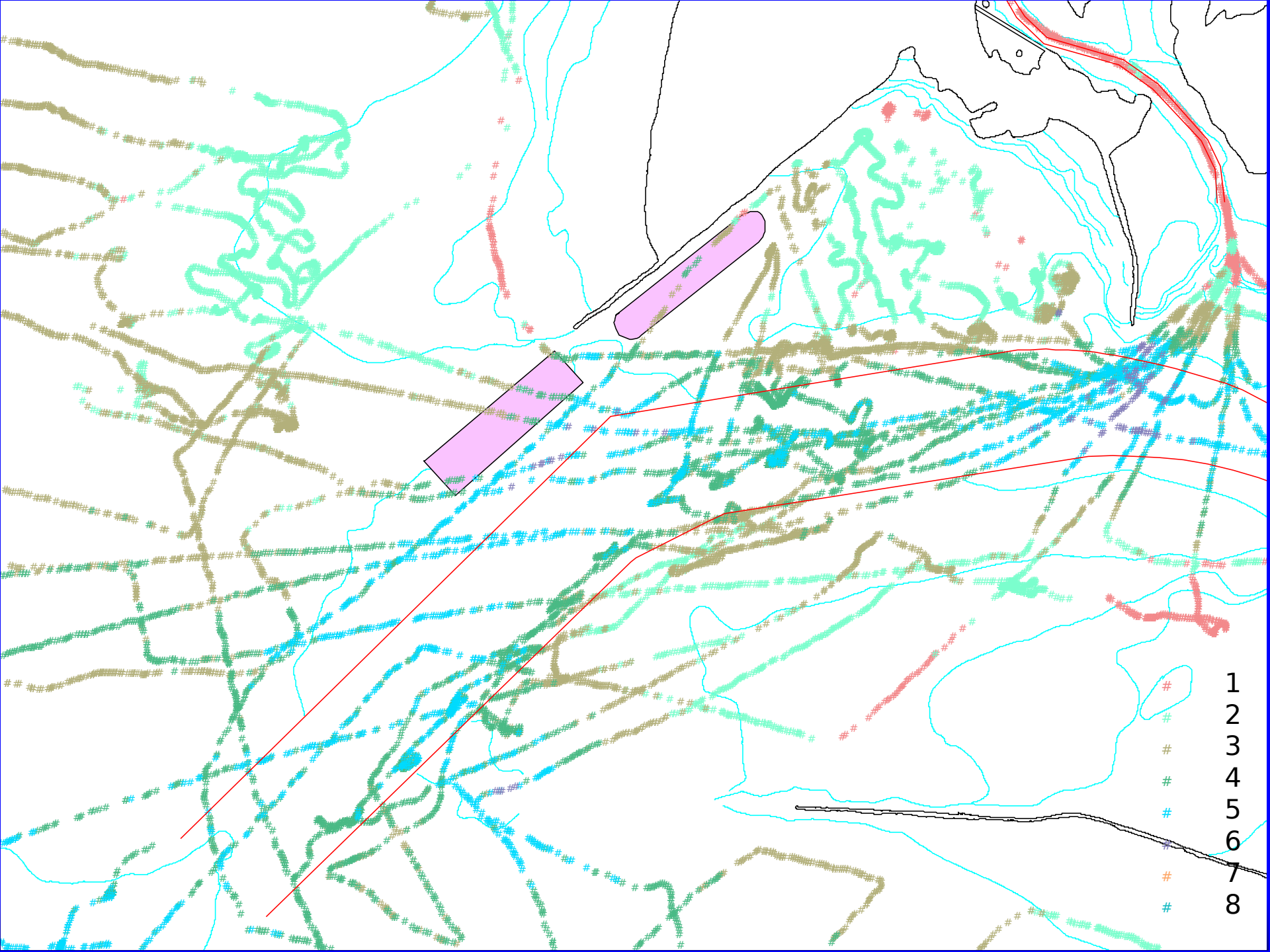
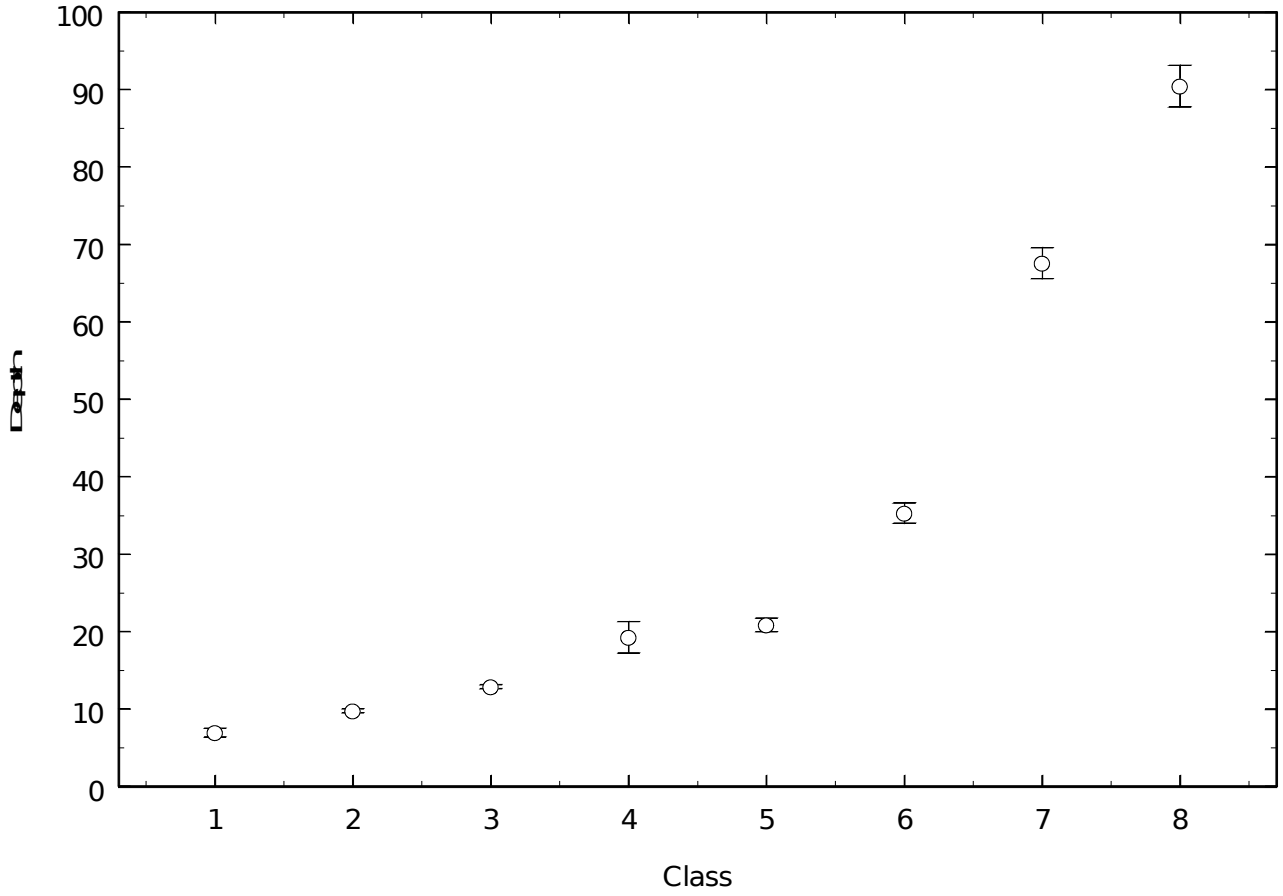

1
2
3
4
5
6
7
8


1
2
3
4
5
6
7
8

characteristics of the classes?

- ABC class data is “blended” with information from the grab samples
- All ABC records within a 20m radius of a grab sample are summarized and connected to the grab sample
- Average characteristics (depth, grain size descriptors, etc.) are computed for each class

The depth of each class



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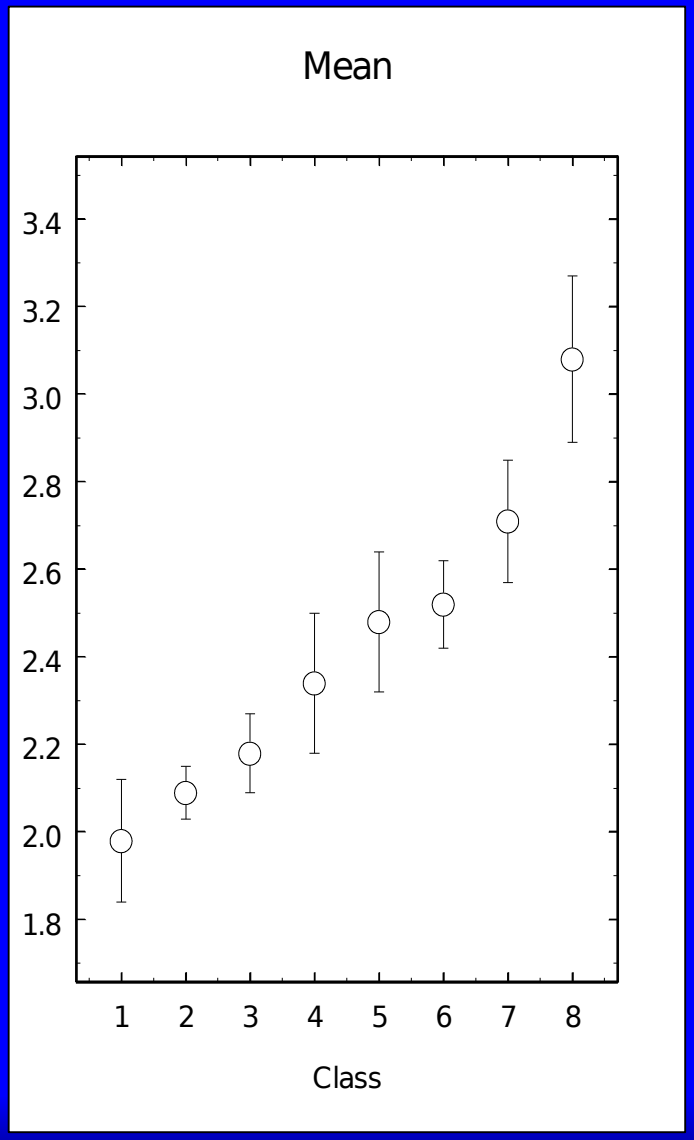
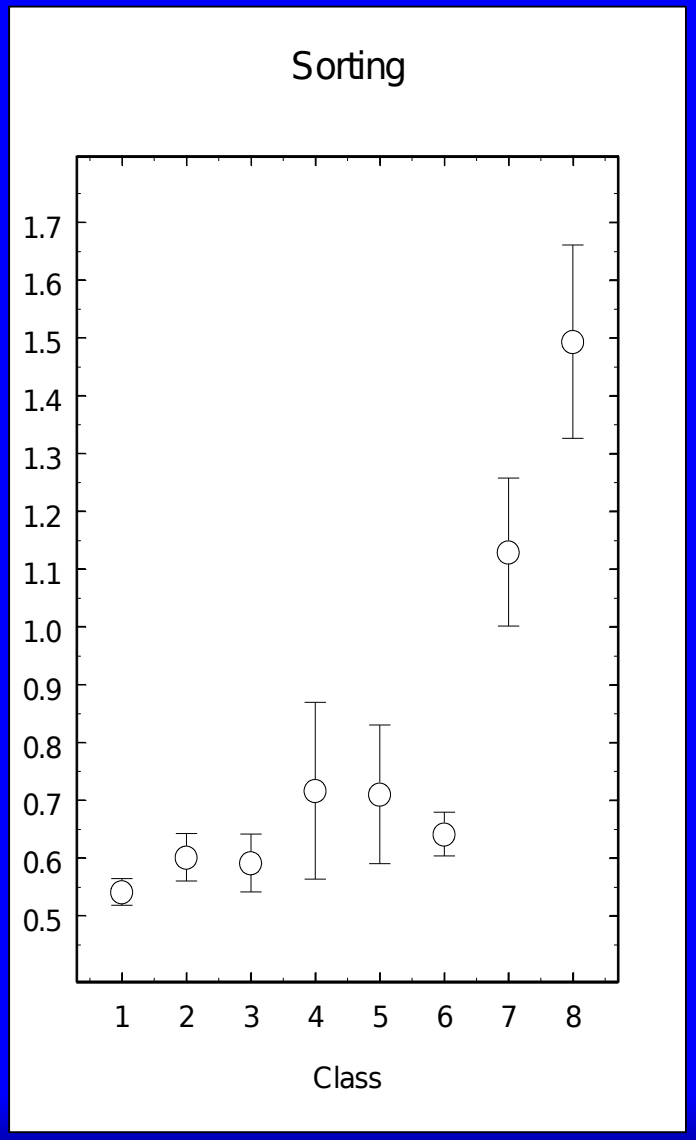
statistics





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descriptions...

Class	Depth (m)	% Sand	Mean grain size	Sort-ing	% Firm	% Biota	% Worms	% Shell	% Moll-uscs
1	6.99	99.68	1.98	0.54	100	0	0	0	0
2	9.78	99.23	2.09	0.60	90	35	53	6	47
3	12.89	99.56	2.18	0.59	100	44	83	0	17
4	19.28	96.72	2.34	0.72	95	68	92	0	15
5	20.88	96.45	2.48	0.71	95	90	78	6	17
6	35.32	96.78	2.52	0.64	98	88	87	17	6
7	67.61	86.58	2.71	1.13	50	76	90	22	2
8	90.46	79.15	3.08	1.49	42	69	87	32	0

Grain size descriptors in phi units.

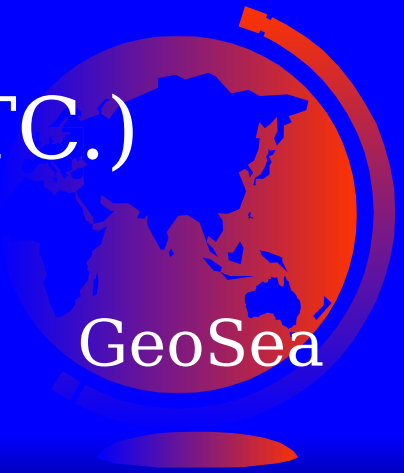
FUNDAMENTAL CONCLUSION

- The ABC failed to show convincing evidence for a unique signature associated with dredged material disposal.

(So lets go to STA)

STA TELLS YOU 2 THINGS

- THE NET SEDIMENT TRANSPORT PATHWAYS IN ANY SEDIMENTARY ENVIRONMENT
- THE DYNAMIC BEHAVIOR OF THE BOTTOM SEDIMENTS (NET EROSION, ACCRETION, DYNAMIC EQUILIBRIUM ETC.)



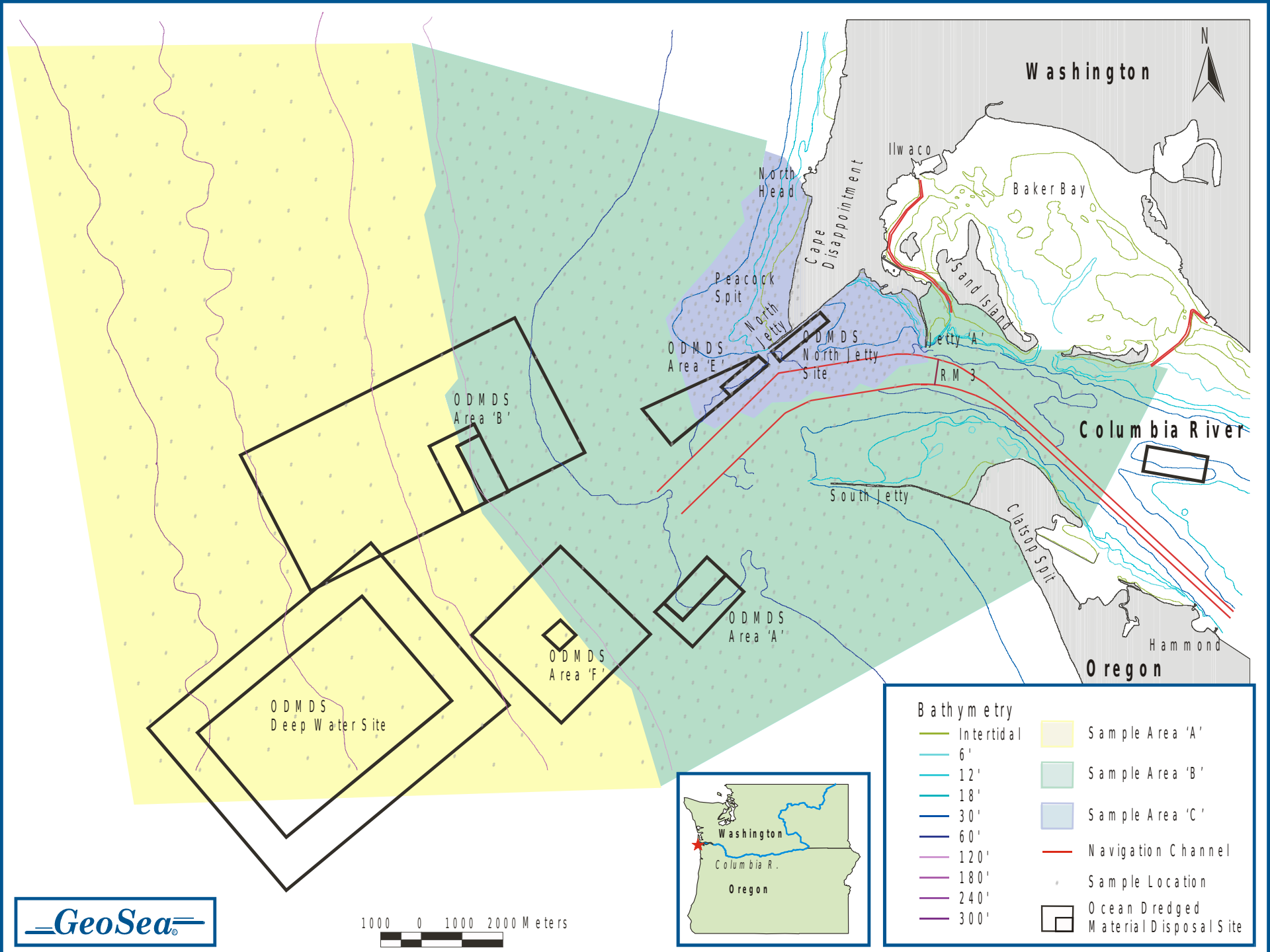
WHAT ARE THE DATA?

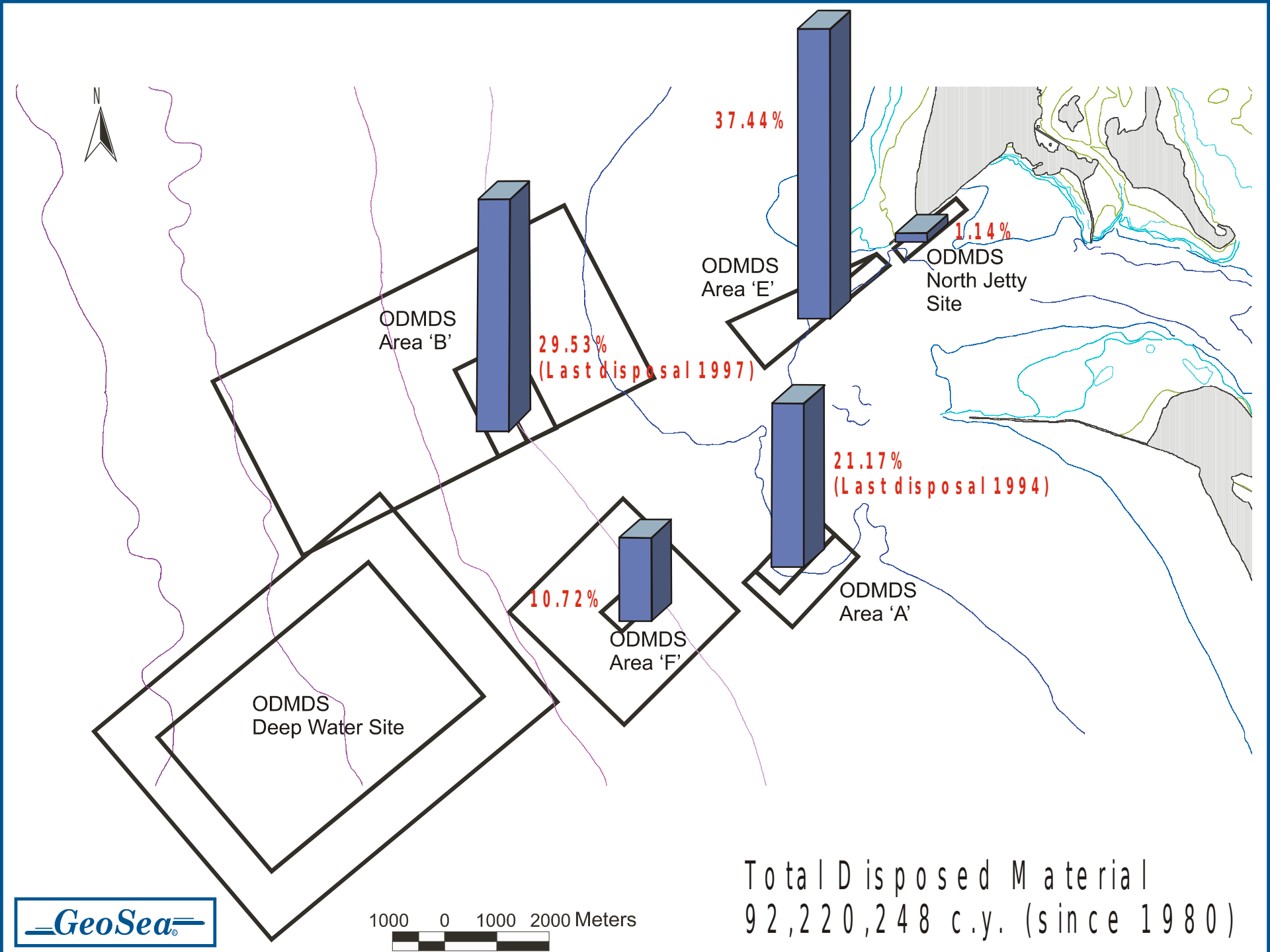
- COMPLETE GRAIN-SIZE DISTRIBUTIONS OF BOTTOM SEDIMENTS
- SAMPLES COLLECTED OVER THE AREA OF INTEREST IN A REGULAR GRID

GeoSea®

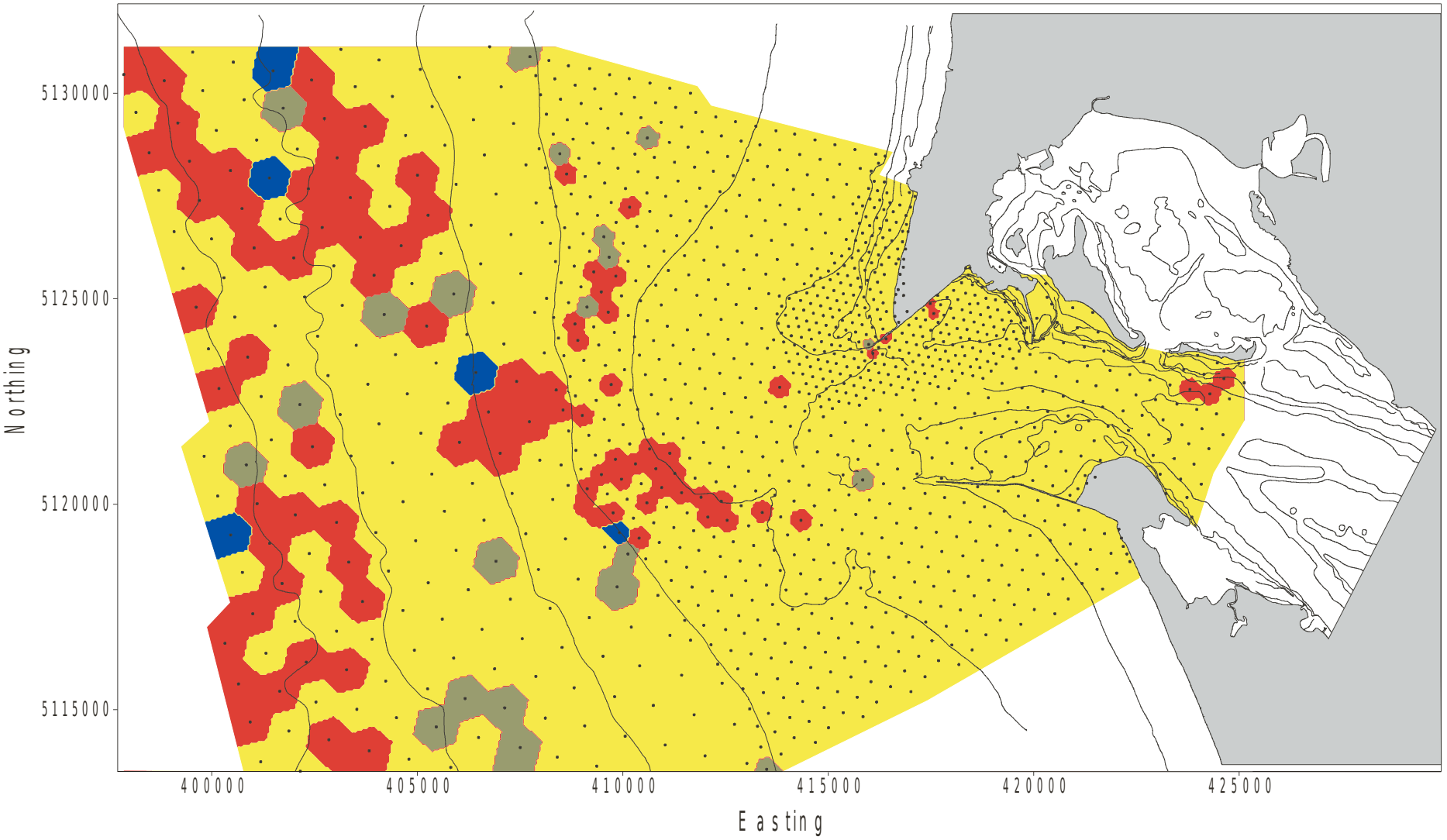
SO YOU WANT TO KNOW THE THEORY?

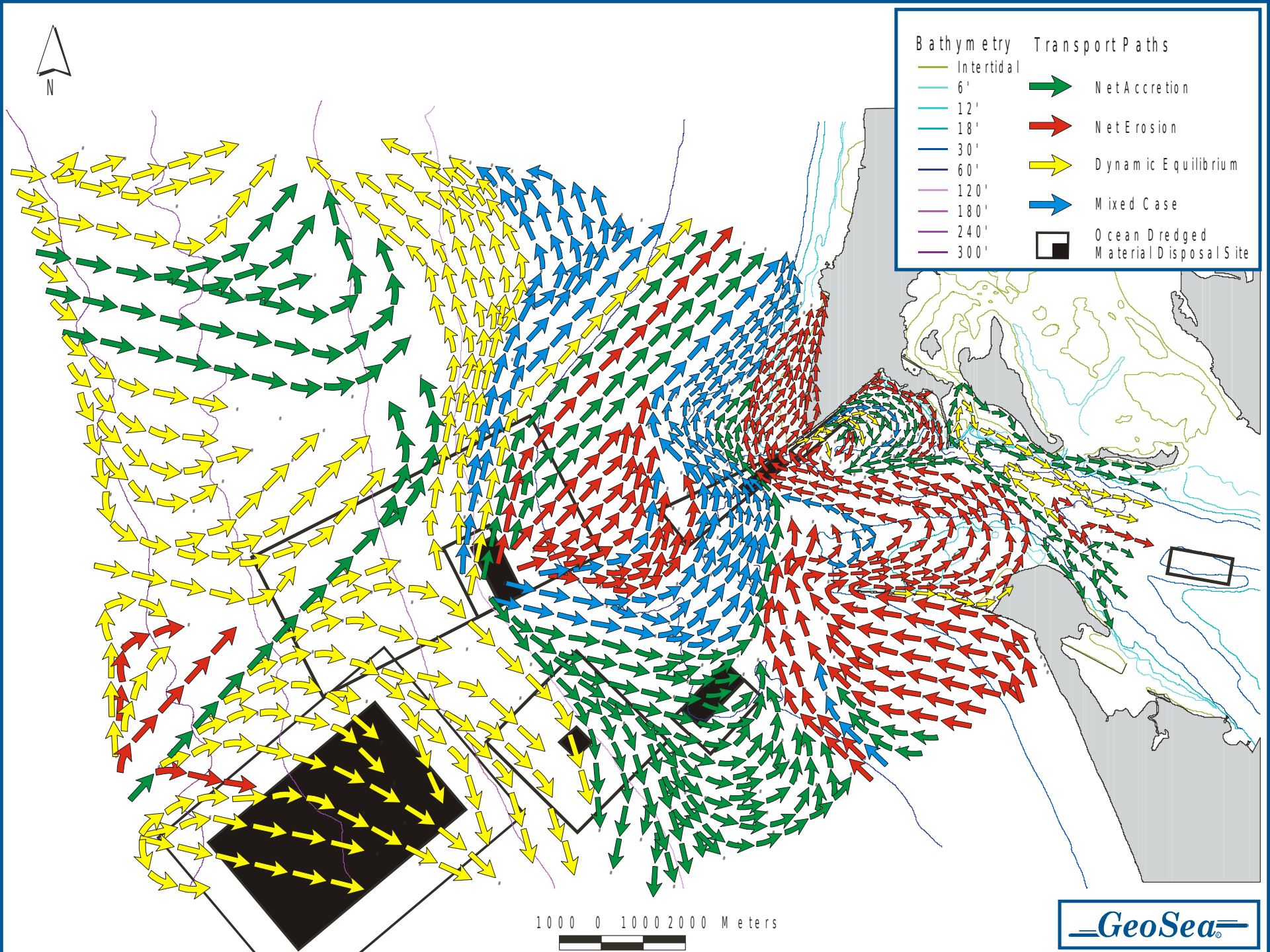
- NOT HERE - MAYBE LATER
- BUT GO TO **WWW.GEOSEA.CA** TO OBTAIN THE COMPLETE THEORY PAPER

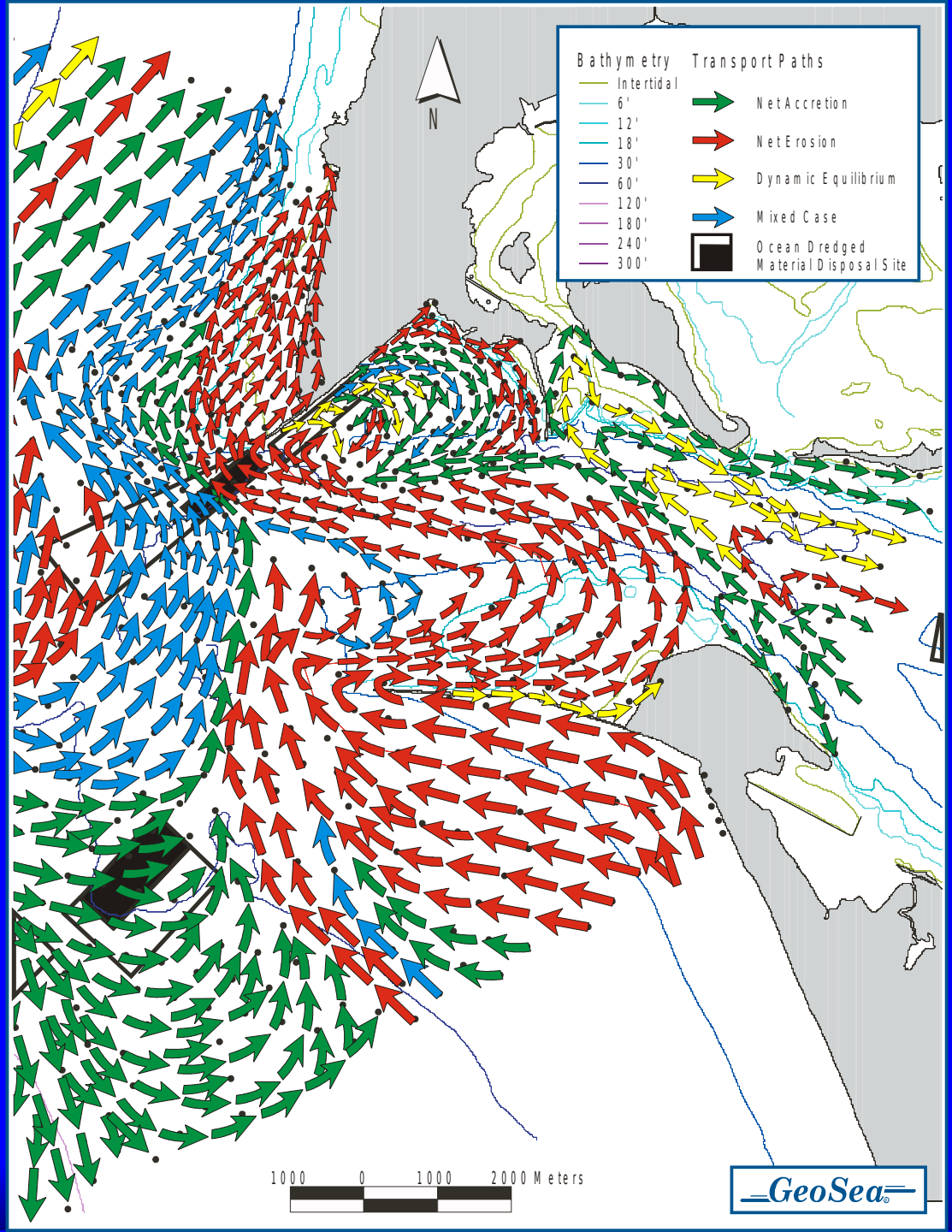

Washington
N
Ilwaco
North Head
Cape Disappointment
Baker Bay
Sand Island
Peacock Spit
North Jetty
ODMDS Area 'E'
ODMDS North Jetty Site
Jetty 'A'
RM 3
Columbia River
ODMDS Area 'B'
South Jetty
Clatsop Spit
ODMDS Area 'A'
ODMDS Area 'F'
Hammond
Oregon
ODMDS Deep Water Site
Bathymetry
Intertidal
6'
12'
18'
30'
60'
120'
180'
240'
300'
Sample Area 'A'
Sample Area 'B'
Sample Area 'C'
Navigation Channel
Sample Location
Ocean Dredged Material Disposal Site
Washington
Columbia R.
Oregon
1000 0 1000 2000 Meters
GeoSea


N
37.44%
ODMDS
Area 'E'
1.14%
ODMDS
North Jetty
Site
ODMDS
Area 'B'
29.53%
(Last disposal 1997)
21.17%
(Last disposal 1994)
ODMDS
Area 'A'
10.72%
ODMDS
Area 'F'
ODMDS
Deep Water Site
1000 0 1000 2000 Meters
GeoSea
Total Disposed Material
92,220,248 c.y. (since 1980)

Sample Type	Number	Percentage
No Sample	21	1.7
Gravel	0	0.0
Sandy Gravel	0	0.0
Gravely Sand	0	0.0
Sand	1138	90.9
Muddy Sand	88	7.0
Sandy Mud	5	0.4
Mud	0	0.0
Other	0	0.0
Total	1252	100.0


5130000
5125000
5120000
5115000
Northing
400000
405000
410000
415000
420000
425000
Easting
No Sample
Muddy Sand
Sand
Sandy Mud


N
Bathymetry
Intertidal
6'
12'
18'
30'
60'
120'
180'
240'
300'
Transport Paths
Net Accretion
Net Erosion
Dynamic Equilibrium
Mixed Case
Ocean Dredged Material Disposal Site
1000 0 1000 2000 Meters
GeoSea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Ocean Dredged Material Disposal Site
N
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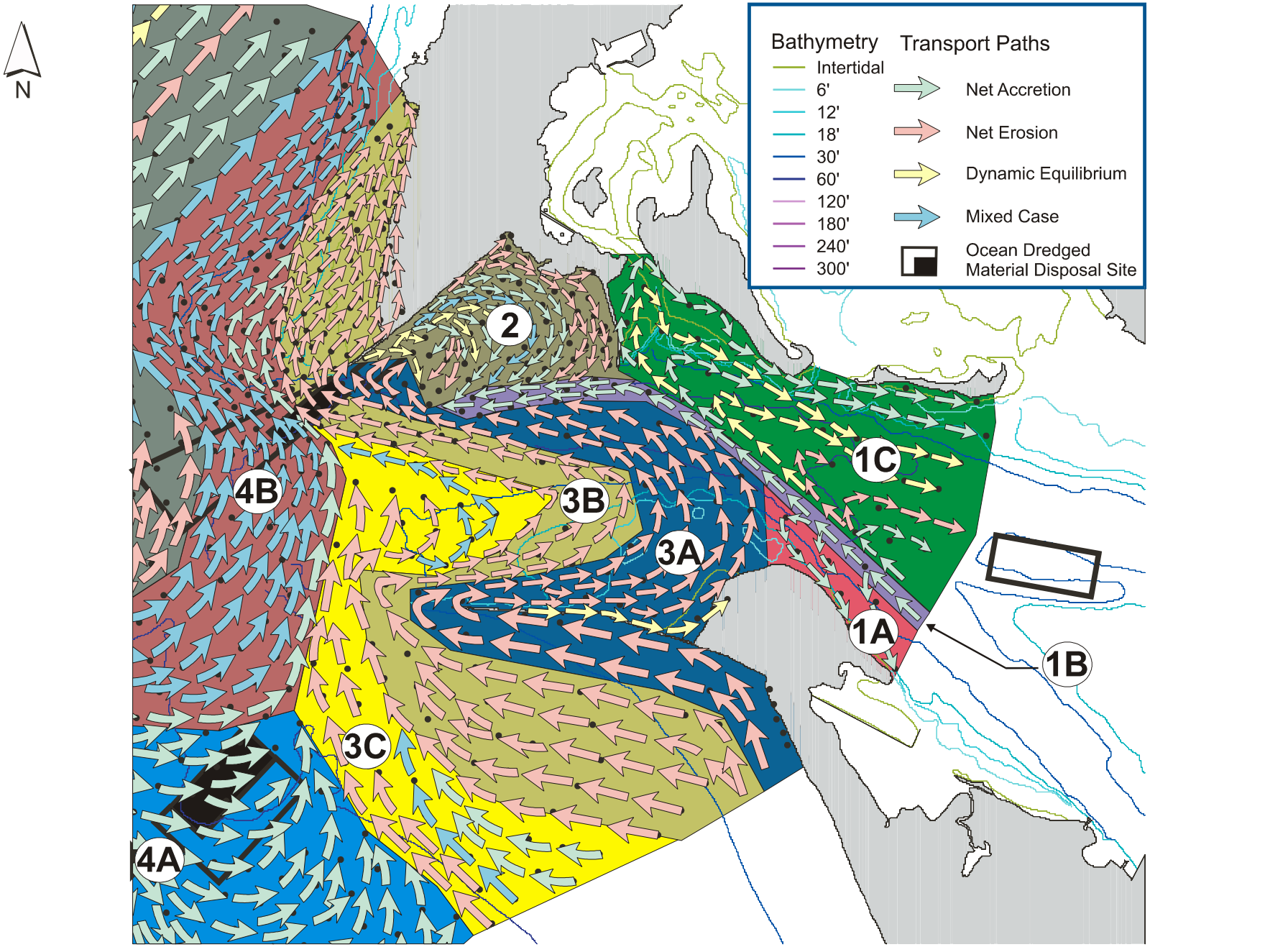
GeoSea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Net Erosion
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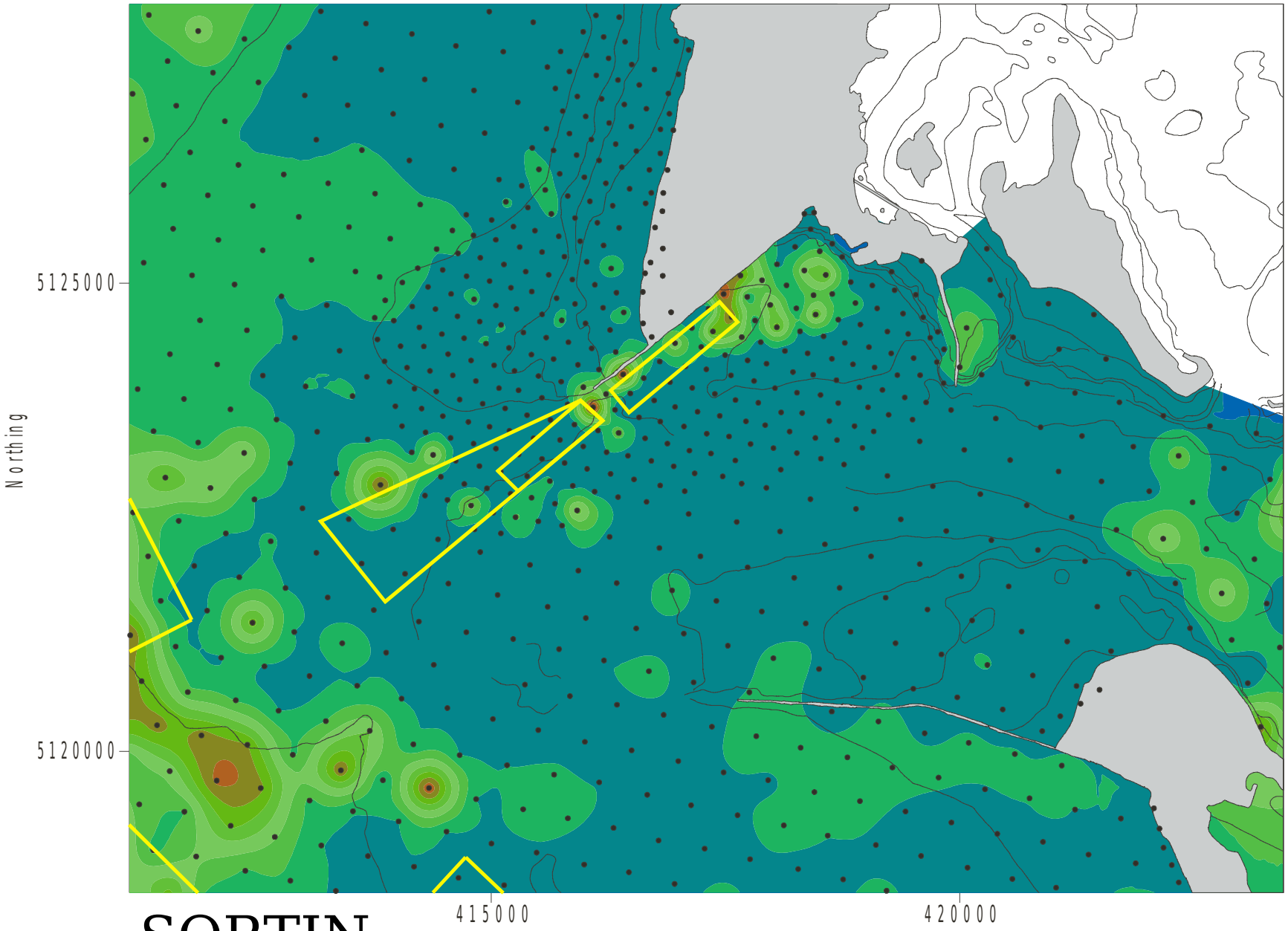
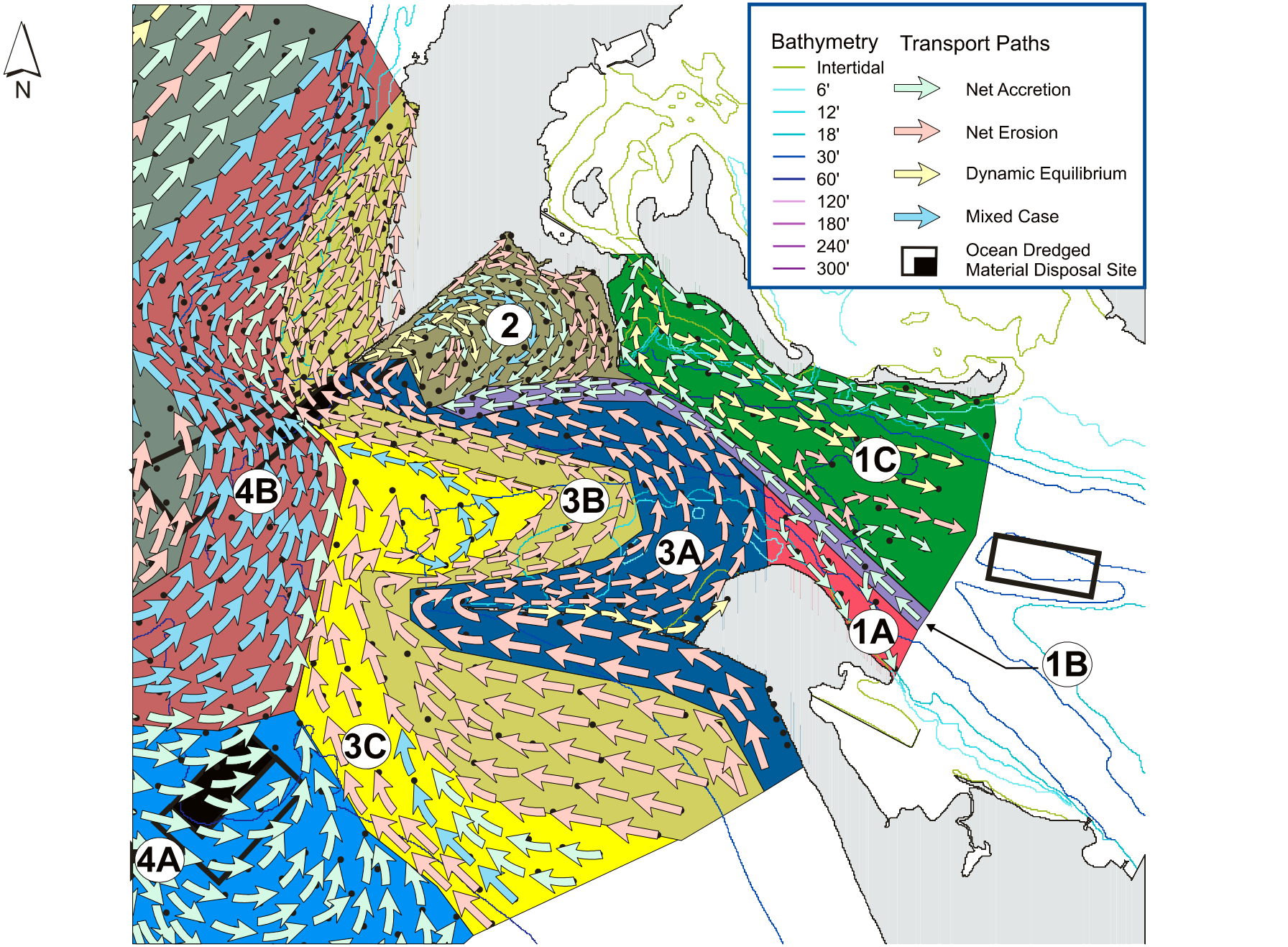
Ocean Dredged Material Disposal Site
2
4B
3B
3A
1C
1A
1B
3C
4A
1000 0 1000 2000 Meters

GeoSea


5125000
5120000
Northing
415000
420000
Easting
SORTIN
G
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2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4B
3B
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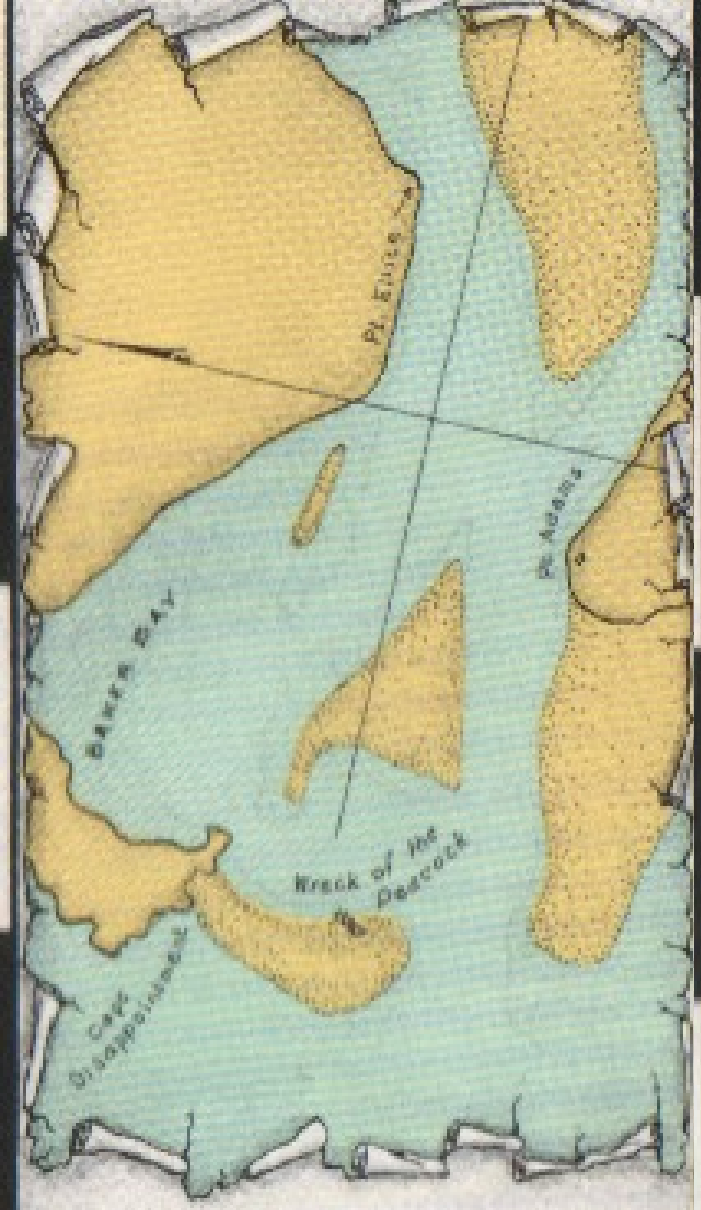
1A
1B
3C
4A
1000 0 1000 2000 Meters

GeoSea

Cape Elizabeth
TAHOLAH
Pt. Grenville
QUINAULT RIVER - SCENE OF MASSACRE BY QUINAULT INDIANS OF 7 SAILORS FROM THE SPANISH SCHOONER "SONORA" WHILE ASHORE IN SEARCH OF FRESH WATER JULY 14 1775.
AMANDA PARK
MOCLIPS
PACIFIC BEACH
HUMPTULIPS
COPALIS BEACH
OCEAN CITY
OCEAN SHORES
Pt. Brown
Pt. Chehalis
WESTPORT
GRAYS HARBOR
HOQUIAM
ABERDEEN
MARKHAM
BAY CITY
GRAYLAND
MAY 7 1792, ROBERT GRAY DISCOVERS AND ENTERS GRAYS HARBOR IN THE SHIP "COLUMBIA REDIVIVIA".
MONTESANO
ELMA
Cape Shoalwater
WILLAPA BAY
TOKELAND
Leadbetter Pt.
RAYMOND
SO. BEND
OYSTERVILLE
OCEAN PARK
KLIPSAN BEACH
MENLO
NEMAH
OCEANSIDE
North Beach Pen.
FURTHEST NORTH POINT REACHED BY WILLIAM CLARK LEWIS & CLARK EXPEDITION, NOV 19, 1805
LEBAM
LONGBEACH
North Hd.
SEAVIEW
Disappointment
PEACOCK SPIT MARKS THE SITE OF THE SHIPWRECK OF THE WILKES EXPEDITION SLOOP "PEACOCK" JULY 9, 1841 - NO CASUALTIES.
NASELLE
FRANCES
DOTY
DRYAD
PE ELL
COLUMBIA RIVER - NAMED AFTER THE SHIP "COLUMBIA REDIVIVA", AMERICAN FUR TRADER ROBERT GRAY ENTERED THE MOUTH OF THE RIVER ON MAY 12, 1792.
CURTIS
Clatsop Spit
FT. STEVENS
HAMMOND
CLATSOP
KNAPPTON
MEGLER
LEWIS & CLARK CAMPSITE NOV 15-25 1805
LEWIS & CLARK CAMPSITE NOV 8-9 1805
ASTORIA
Tongue Pt.

GeoSea

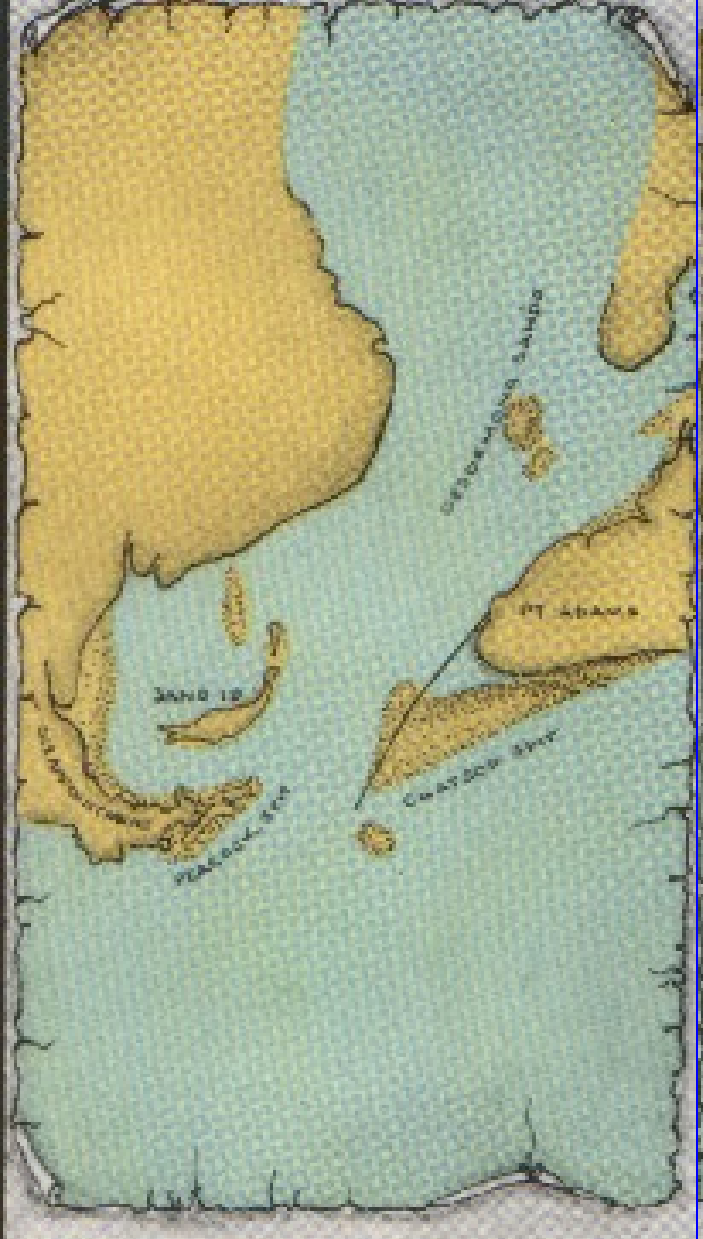
GeoSea



River entrance in
1844

River entrance in
1876

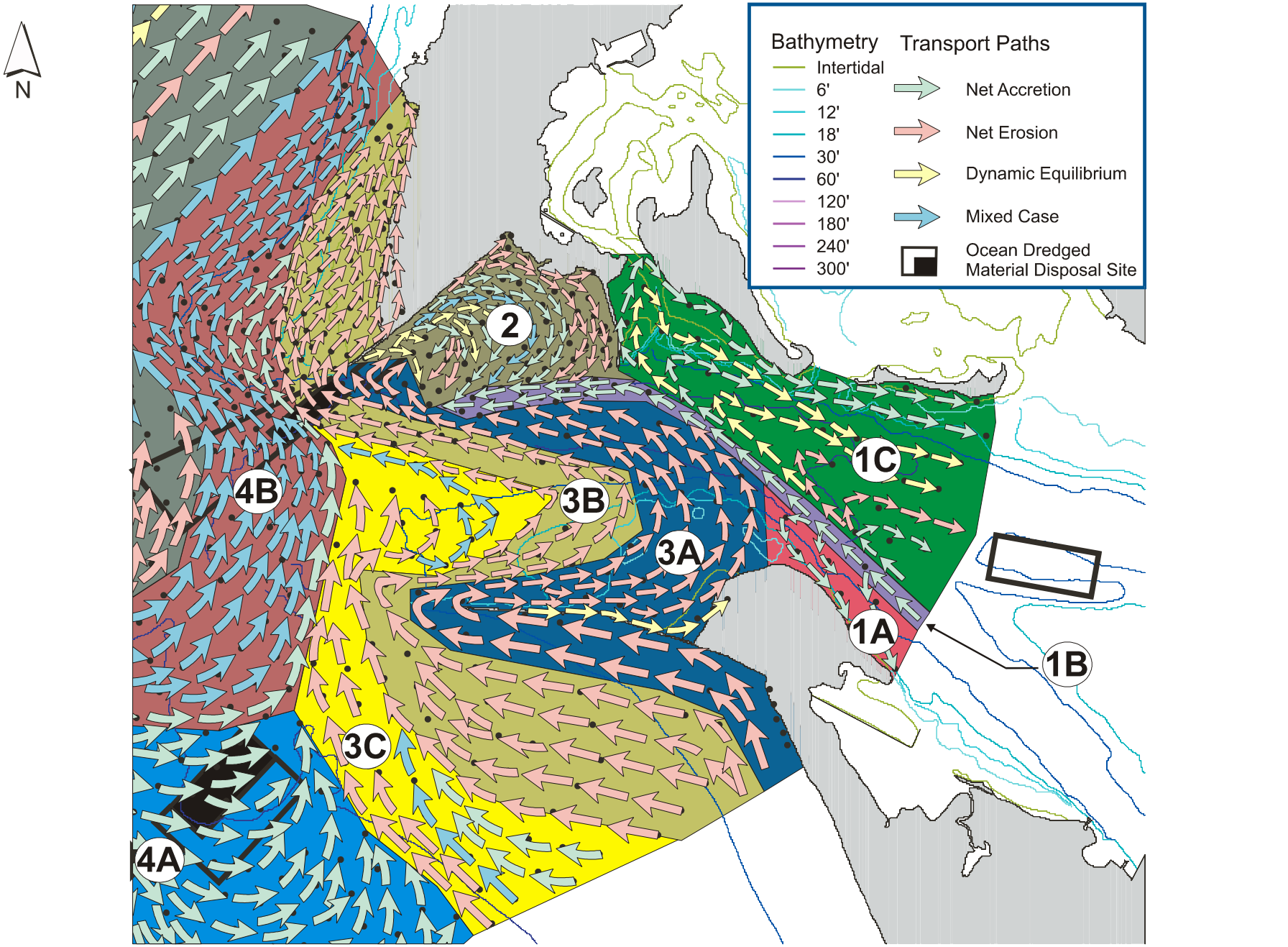
GeoSea



River entrance in 1895

River entrance in 1910

GeoSea


N
Bathymetry
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6'
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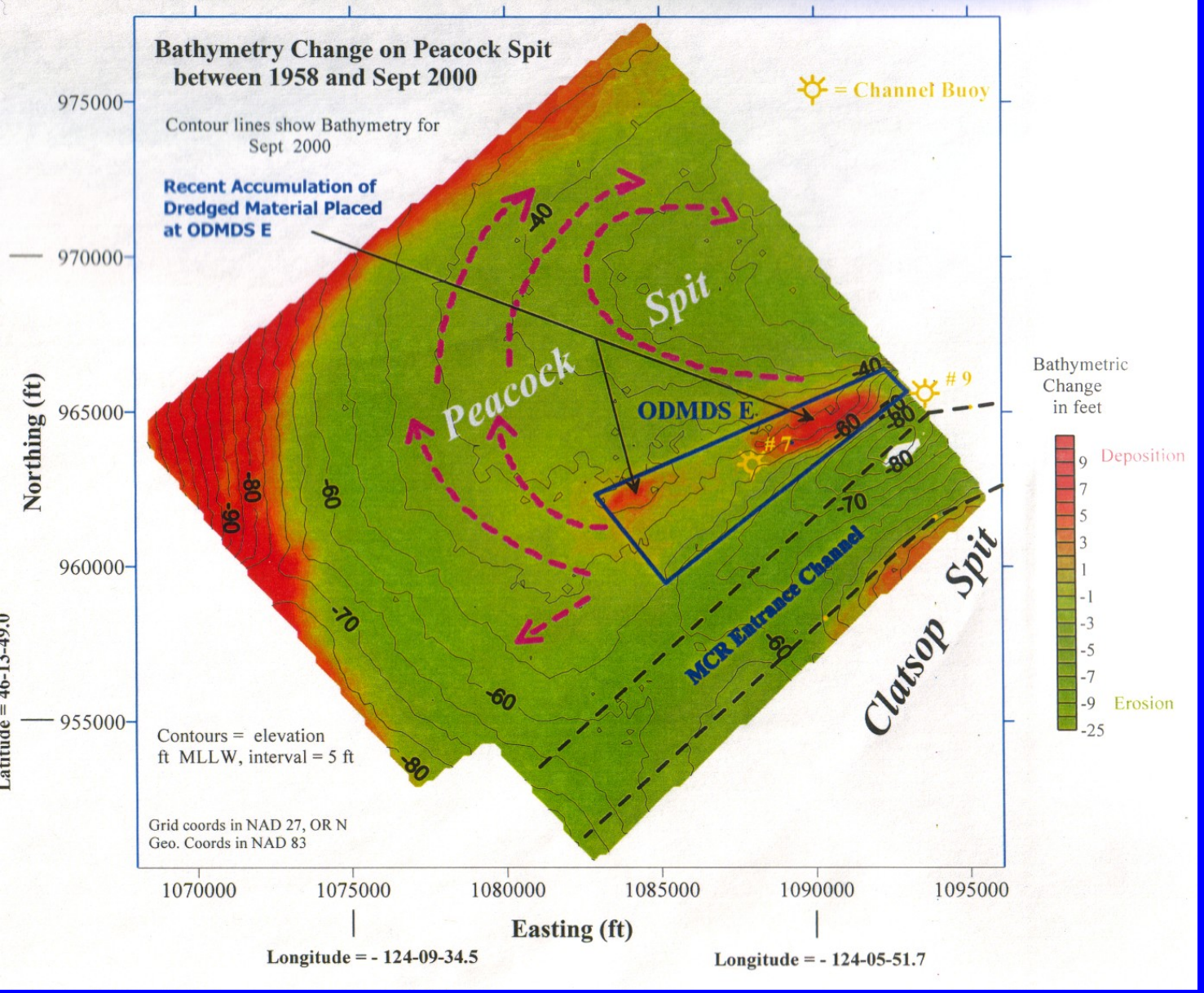
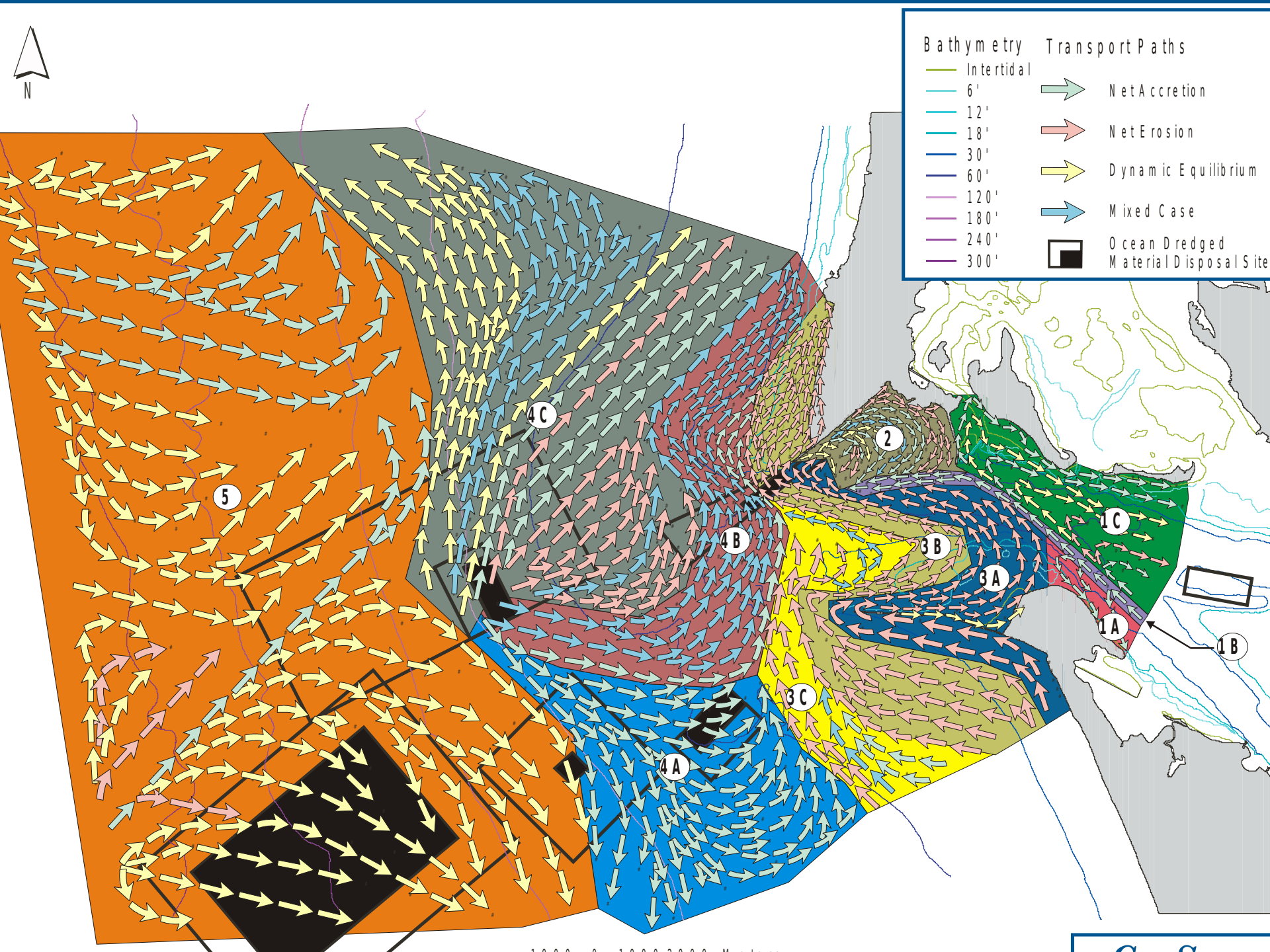
240'
300'
Transport Paths
Net Accretion
Net Erosion
Dynamic Equilibrium
Mixed Case
Ocean Dredged Material Disposal Site
2
4B
3B
3A
1C
1A
1B
3C
4A
1000 0 1000 2000 Meters

GeoSea


Bathymetry Change on Peacock Spit
between 1958 and Sept 2000
Contour lines show Bathymetry for
Sept 2000
Recent Accumulation of
Dredged Material Placed
at ODMDS E
= Channel Buoy
Peacock
Spit
ODMDS E.
9
7
MCR Entrance Channel
Clatsop Spit
Bathymetric
Change
in feet
9 Deposition
7
5
3
1
-1
-3
-5
-7
-9 Erosion
-25
Contours = elevation
ft MLLW, interval = 5 ft
Grid coords in NAD 27, OR N
Geo. Coords in NAD 83
Northing (ft)
975000
970000
965000
960000
955000
Latitude = 46-13-49.0
1070000
1075000
1080000
1085000
1090000
1095000
Easting (ft)
Longitude = - 124-09-34.5
Longitude = - 124-05-51.7

GeoSea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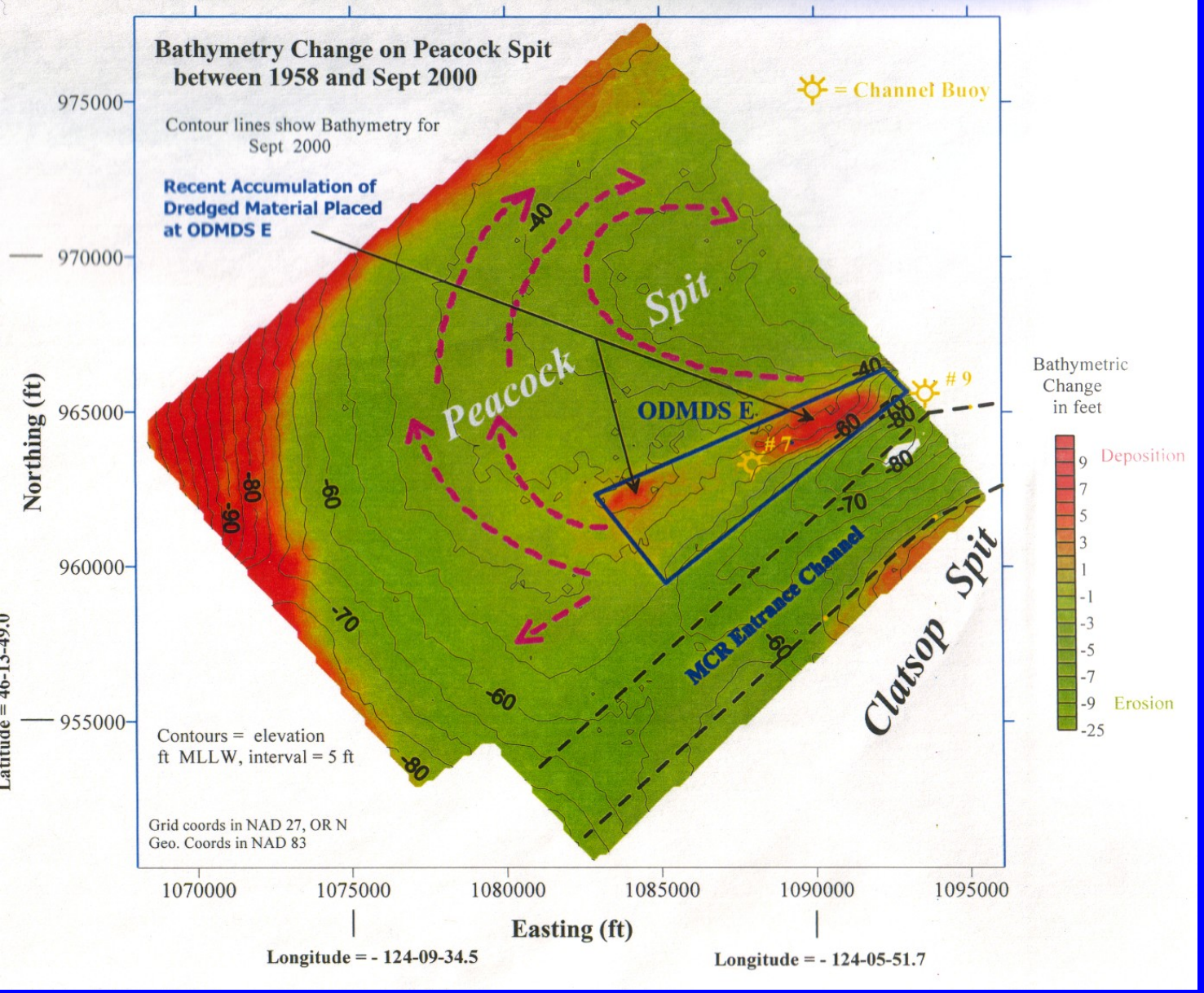
4B
4C
5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Spit
ODMDS E.
9
7
MCR Entrance Channel
Clatsop Spit
Bathymetric
Change
in feet
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7
5
3
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-1
-3
-5
-7
-9 Erosion
-25
Contours = elevation
ft MLLW, interval = 5 ft
Grid coords in NAD 27, OR N
Geo. Coords in NAD 83
Northing (ft)
975000
970000
965000
960000
955000
Latitude = 46-13-49.0
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1075000
1080000
1085000
1090000
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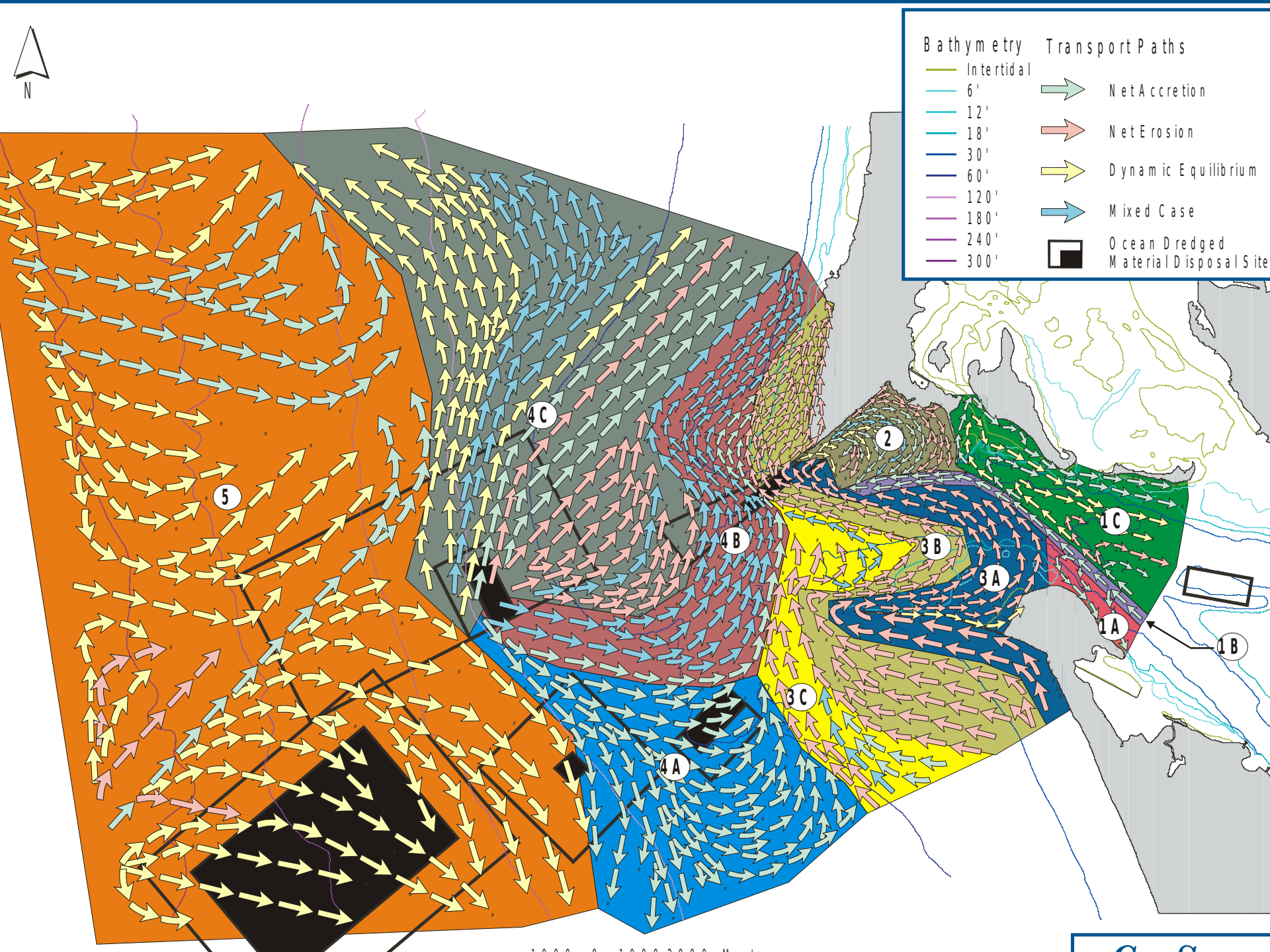
Easting (ft)
Longitude = - 124-09-34.5
Longitude = - 124-05-51.7

GeoSea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6'
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Dynamic Equilibrium
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Ocean Dredged Material Disposal Site
1A
1B
1C
2
3A
3B
3C
4A
4B
4C
5

GEOMORPHOLOGY CONCLUSIONS

- The present bar at the Columbia River mouth is not behaving as an ebb tidal delta.
- It is, therefore, a relict feature that may well be eroding due to lack of replenishment from the river.
- Marine processes dominate the sediment transport regimes compared to the river.
- Peacock Spit is not a spit, but a classic down-drift offset (part of an important sediment bypassing system from south to north).

DISPOSAL CONCLUSIONS

- No clear sedimentological evidence for any of the disposal sites – except for the North Jetty disposal site.
- This means:

(A): dredged sediments are so similar to "natural sediments" that we can't tell them apart.

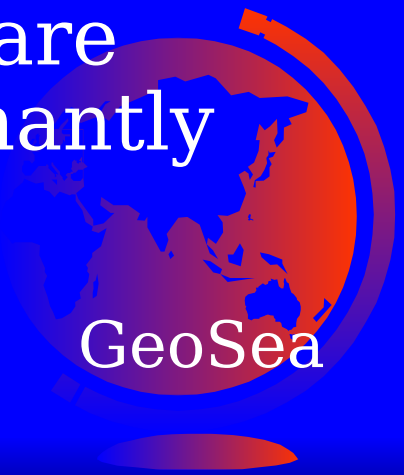
(B) or, dispersal of dredged material is rapid and quickly diluted with the natural sediments.

These are not mutually exclusive.

The same conclusion is reached from the findings of the

COASTAL EROSION CONCLUSIONS

- Not much sediment getting from river to the bar. More sediment in the past.
- The source for the beaches is, at present, mainly marine (maybe originally Columbia River sediments).
- All beach and nearshore areas are sediment starved and predominantly eroding.



- Placement of sand in TE 3B definitely a good thing for shoreline replenishment to the north.
- Sand from the bar can make it to beaches south of the entrance, but must travel southwards in the offshore, before being returned to the northward, nearshore regime.